[Editorial] Strategies and practices for inclusive manufacturing: 21st century sustainable manufacturing competitiveness

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Editorial

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Strategies and practices for inclusive manufacturing: 21st Century Sustainable Manufacturing Competitiveness

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Abstract: This editorial introduces the purpose of the special issue with the summary of three perspectives of innovations in inclusive manufacturing such as people-oriented, environmental oriented and technology oriented innovations. The editorial summarise the accepted papers based on the three perspective of inclusive manufacturing innovation classification. The inclusive manufacturing way forward is discussed in the future research directions section. Overall this call didn't receive many people-oriented innovation submissions. However, there are a decent amount of work in environmental and technology oriented innovations. Hopefully this editorial piece will draw attention towards people-oriented innovation from the manufacturing researchers in the future.

Keywords: Sustainable manufacturing, inclusive manufacturing, competitiveness

1. Introduction

Whilst firms previously used extensively computing power to become smart and improve productivity, the 21st century firms have multiple challenges out of which social and environmental aspects are the major issues. Firms are seeking new ways to integrate social and environmental practices with computer integrated manufacturing to develop unique capabilities to improve their sustainable competitiveness. Other than conventional firm performance objectives of cost, quality, speed, flexibility and dependability, there is now a requirement for firms to deliver on sustainable objectives. Sustainable development refers to the development that meets the needs of the present without compromising the ability of future generations to meet their own needs. In the past two decades the public and business sectors, as well as government and international agencies, have begun to embrace the broad concept of sustainable development, with its proposition that 'economic growth can occur while simultaneously protecting the environment' (World Commission on Environment and Development, 1987).

The tremendous growth of emerging economies, and subsequently becoming attractive manufacturing bases in the world, raises the question of how to make the manufacturing practices sustainable (Subramanian and Gunasekaran, 2015). That is, how to manage resource shortage, reduce non-value-added activities, mitigate environmental degradation and reap the greatest soft potentials of human beings. Manufacturing plays a vital role in emerging

economies growth and exports. A recent study carried out by Stanford graduate school of business indicates that HP has gained substantial business benefits by implementing social and environmental practices in their contract manufacturing facility in China. The major benefits reported are social benefits achieved through health and safety procedures. It was also stated that training yielded significant reduction in lost productivity. Good for business practices resulted in 0.5% reduction in attrition rate with a firm of 15,000 workers leading to savings of US $310,000. Similarly, investment in simple environmental projects resulted in new design for environment to reduce cost, effluent recycling to reduce water usage and continuous improvement initiatives (Rammohan, 2008).

Though sustainable development is relatively early in its adoption cycle in emerging economies, it has been embraced in many developed countries in various forms starting from waste hierarchy to the recent sustainable hierarchy. The aim of this special issue is to portray how far the emerging economies' computer integrated manufacturing firms are aware of the sustainable hierarchy and prevention approaches which focus on several ‘R’s’ (reduce, reuse, recycle, redesign, remanufacturing and recovery) in addition to innovative practices and strategies to promote sustainable manufacturing.

Overall sustainable manufacturing is also referred as inclusive manufacturing which encompasses three perspectives such as people-oriented, environment and technology oriented innovations. In terms of people it mandates to include all categories of people in various manufacturing activities irrespective of their age, gender, economic, political and social status to improve the skill set of future workforce, encourage rural innovation, solicit open source designs and the development of new business models. In terms of environment it encourages companies to consider product life cycle and safe handling of end-of-life product. Final perspective includes the role of technology such as cloud computing, Internet of things and big data algorithms (IMF, 2017).

The special issue solicited paper from the following topics as per the three perspectives of inclusive manufacturing:

<u>People oriented innovation</u>

- *Human welfare issues on sustainable competitiveness*
- *Innovative practices and sustainable performance in manufacturing*
- *Organizational proactive management strategies sustainable competitiveness*

- *Cultural aspects in sustainable manufacturing competitiveness*

Environmental oriented innovation

- *Sustainable manufacturing and competitiveness drivers*
- *Environmental management practices and sustainable competitiveness*
- *Reverse logistics and supply chain management in computer integrated manufacturing*
- *Sustainable manufacturing practices*
- *Eco innovation and sustainable competitiveness*
- *Remanufacturing strategies and sustainable competitiveness*
- *Sustainable manufacturing competitive performance measurement.*
- *Corporate social responsibility and sustainable manufacturing competitiveness*

Technology oriented innovation

- *Influence of technology on sustainable competitiveness*
- *Carbon efficient manufacturing and sustainable supply chains*
- *Techno-socio-eco efficient indicators*

Seven papers have been accepted out of several papers submitted to the special issue. The papers went through a rigorous review process. We would like to thank the reviewers and the Editor-in-Chief for their generous support to successfully complete this project. We pay our sincere appreciation to the journal professional support team for their wonderful support and reminders to monitor the submissions by the authors. The summary of papers accepted for the special issue is discussed in the next section.

2. Review of special issue papers

This section categorises the accepted papers as per the three perspectives of inclusive manufacturing. We had received one paper under people-oriented innovation category and three submissions each under environmental and technology-oriented innovations. The details are as follows.

2.1 People oriented innovation

Peruzzini and Pellicciari propose an analytical approach to include user experience of manufacturing and assemble process from early phase of design to support sustainable manufacturing. The authors demonstrated the viability of model using an automated case study which enabled the manufacturers to achieve 30% reduction in time savings, 20% reduction in cost savings, 25% in reducing environmental impact and 30% in improved user experience. The study portrayed the ignorance of social dimensions especially people's role in terms of

various working ergonomic conditions such as environment, visibility, level of attention, posture, weight and frequency. The study discussed the role of three-dimensional sustainability perspectives and proposed CAD based computer integrated framework.

2.2 Environmental oriented innovation

Song and Wang discusses the potential harmful effect of manufacturing companies' pollution on local community. Primarily the authors suggest potential mitigation strategies to reduce pollution emission and economic impact by relocating the manufacturing companies from greater cities such as Beijing-Tianjin-Hebei city circle to the outskirts of over 150 kms using regression discontinuity method. The authors study the clustering and radiation effects of companies towards mega cities. Interestingly authors find companies located outside Beijing-Tianjin-Hebei city circle got affected only by production biased technical progress. However, companies nearer to the city circle were affected by both production and environmental biased technical progress.

Zhan et al show the association of combined effect of lean and green practices implementation with environmental pressures and performance in the Chinese manufacturing organisations. The authors specifically focused on the following factors: Mindset and attitude, leadership and management, employee involvement, integrated approach and tools and techniques. Overall authors' findings reveal that lean and green practices implementation are in an early stage of implementation. However, Chinese organisations are still learning and yet to convert these philosophies into actions. In addition, authors find the influence of regulations, infrastructure and government support to actively engage manufacturers towards inclusive manufacturing.

Cupek et al determined machine energy consumption profiles in the context of mass-customised manufacturing. Authors proposed a new monitoring approach that combines precise energy consumption monitoring with the production profile without depending on the statistical methods. The new monitoring approach addresses two main issues such as creation of energy consumption profile as per technical production and the detection of energy consumption anomalies. The authors demonstrated the potential benefits of the approach with an industrial case study.

2.3 Technology oriented innovation

Hao et al developed a cloud-based Enterprise Portal for creating a virtual enterprise which enabled small and medium manufacturers in different tiers of supply chain echelons to collaborate. The authors proposed a virtual factory information system design model using two European case studies. Predominantly the model addressed sustainability issues such as

reduction of environmental impact and waste minimisation, substantial savings in cost and benefits to society in manufacturing and enhanced information transfer across manufacturers through Enterprise Portal.

Dhiravidamani et al propose a computer based lean audit methodology to improve production attributes such as quality and reduction of lead time and non-valued time. The authors integrated Kobetsu-Kaizen and value stream mapping for improvement and computer support lean audit to improve production performances and avoid various defectives. The study shows significant improvement is possible in reducing quality rejections by 2.02% and 60% reduction of non-value added activities.

Shamsuzzoha and Helo explains the usefulness of collaborative approach in planning and monitoring the development of innovative product. The authors focused on benefits of collaborative bill-off-materials, scheduling and process monitoring using IT based web enabled software tools in real time environment. The authors validated the idea using a business case network of Shoe Company in the Italian context. This is a pragmatic study with several implications towards inclusive manufacturing.

3. Future directions

Overall the accepted papers reveal the research studies in all three perspectives of inclusive manufacturing are primitive and further studies should focus on the aspects discussed below and the big picture is shown in the figure 1.

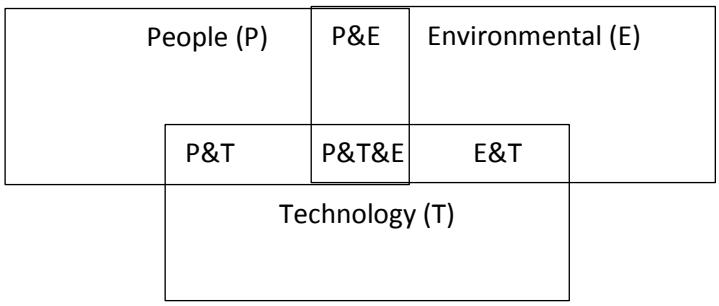

Figure 1: Inclusive manufacturing perspectives

3.1 People

Ergonomics aspects has been considered however future studies need to consider inclusion of new business models considering people, open source innovation, competency and skills needed for future work force, social capital issue needs attention such as gender, pay gap, cultural and economic status of skilled work force. Overall impact on employees and external holders based on inclusive manufacturing has not been studied till now. In addition, the work

force should be dynamic and need to be intra-prenuers based in the 21st century where people must take risk and to be super creative in dealing future manufacturing scenario.

3.2 Environmental

This special issue did not attract any specific studies that deal with several R's (reduce, reuse, recycle, redesign, remanufacturing and recovery). Specifically, paucity of studies in design for reducing loss exist.

The community involvement is critical to ensure its support for people's commitment and awareness to environmental sustainability through responsible manufacturing. There are other factors including policies and procedures to ensure the reduction is carbon footprint by manufacturing companies. The culture of environmental protection should be everywhere in manufacturing. There is a need for further research on the impact of education and training of people about environmental implications in sustainable manufacturing. More empirical and case study research would be of help.

The value-based engineering focuses on looking at the components and parts from the perspective of adding value to the products and customers. Those components and parts should be reliable and meets the functional expectations of customers. This has a great impact on the environment by reducing the carbon footprint and energy usage. Also, strategies/techniques such as reduce, reuse, recycle, redesign, remanufacturing and recovery should be incorporated in modelling and analysis of sustainable manufacturing. Further studies are required to study the impact of value-based engineering and that value should include environmental values.

Product life cycle management is the right approach for ensuring the environmental sustainability. The aspects of life cycle management of a product cover the period ranging from extraction of the raw materials until the product goes back to the earth. The design for manufacturing, design for engineering, design for quality and design for assembly focus on the product life cycle management. The future implications of using certain raw materials and components or parts will be huge in terms of manufacturing lead-time, carbon footprint and energy usage. This area requires further research using forecasting or optimization model for studying the impact of product life cycle management on environments. Also, the product life cycle management for sustainable manufacturing requires case studies and empirical research.

3.3 Technology

The technologies play a major role in developing and managing an inclusive manufacturing for sustainability and some of them include micro manufacturing, the Internet of Things, Computer aided product engineering and life cycle management and smart logistics.

The impact of technologies promotes automation and less human errors and delays by avoiding inefficient process rework, scrap, increase in carbon footprint and energy usage. Further research is requiring to study the impact of micro manufacturing, IoT and smart logistics on sustainable manufacturing. More empirical and case study research are required.

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